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RESEARCH ARTICLE

Comparison of visual reaction time in myopic subjects with emmetropic subjects

Saravanan Mohanraj[1], Aravindan Karthikeyan[2]

[1]Assistant Professor, Department of Physiology, Velammal Medical College Hospital and Research Institute, Madurai, Tamil Nadu, India, [2]MBBS Student, Velammal Medical College Hospital and Research Institute, Madurai, Tamil Nadu, India

Correspondence to: Saravanan Mohanraj, E-mail: saravanan_apk@rediffmail.com

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ABSTRACT

Background: Reaction time is the time between presentation of a stimulus and the appearance of appropriate voluntary response in the subject. The measurement of visual reaction time (VRT) is used to evaluate the processing speed of central nervous system and co-ordination between the visual sense and motor system. Refractive errors were proved to affect the accommodation reaction. Defocusing was known to affect the VRT. However, the influence of the refractive error on VRT was not clearly documented. As blur, defocus, illumination affect lot of psychomotor skills like driving, refractive errors also expected to affect the psychomotor skills. **Aims and Objectives:** This study was undertaken with a purpose to measure and compare the VRT in myopic subjects with and without correcting the refractive error with that of VRT of emmetropic subjects. **Materials and Methods:** The study was carried out among 112 first year medical students in the age group 18 to 20. 60 emmetropic subjects and 52 myopic subjects were involved in the study. The study was carried out with the help of discriminatory and choice reaction time apparatus. VRT was measured in milliseconds. For myopic subjects, VRT was taken before and after correction of their refractive error. Subjects were presented with two visual stimuli, red and green. **Result:** VRT is found to be significantly more in uncorrected myopic subjects as compared to emmetropic subjects for both red and green light stimuli. VRT is found to be significantly less in emmetropic subjects as compared to myopic subjects even after correcting the refracting error. **Conclusion:** The myopic people have greater reaction time than emmetropic people even though when their refractive error is corrected. This adds refractive error as a new member in the row of factors that affects the VRT.

KEY WORDS: Visual Reaction Time; Myopia; Emmetropia

INTRODUCTION

Myopia is one among the most prevalent refractive error of many young people. The "Near Work" hypothesis states that many aspects of our modern environment involve near work, which strains our eyes.[1] For example, reading books and looking at computer and phones which have pixelated screens for a long period. The majority of people in the modern world spend most of their time in doing work termed as "Near Work." Studying for long hours is also a strain to the eye; particularly in student age group. This is especially seen in children whose eyes are still developing. Hence, their eyes may grow permanently elongated and myopic.

As the myopic population is growing day by day, there comes a necessity to find the short comes of myopia. This present study has been conducted to check whether myopia has an impact on binocular simple visual reaction time (VRT).

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Reaction time is the time between presentation of the stimulus and the appearance of appropriate voluntary response in the subject. The measurement of VRT is used to evaluate the processing speed of central nervous system and co-ordination between the visual sense and motor system. Various factors such as age, sex, left or right handedness, central versus peripheral vision, fatigue, fasting, breathing cycles, personality type, exercise, and intelligence were known to influence the reaction time.

Refractive errors were proved to affect the accommodation reaction. Defocusing was known to affect the VRT. However, the influence of the refractive error on VRT was not clearly documented. As blur, defocus, illumination affect lot of psychomotor skills like driving, refractive errors also expected to affect the psychomotor skills.

Reaction time experiments are classified by psychologists into three basic kinds:[2,3] Simple reaction time experiment, recognition reaction time experiment, and choice reaction time experiment. Simple reaction time experiments take a single stimulus and studies single response. The popular phrases used to describe this process are: "X at a known location," "spot the dot," and "reaction to sound" to measure the simple reaction time. Recognition type experiments focus on the responses of recognition called "memory set" and "distractor set." As the response pertains to the memory of the user, there is only one correct response. There are two major types of recognition experiments: "Symbol recognition" and "tone recognition."

In choice reaction time experiments, the corresponding of the response to the stimulus given to the user is tested. A well-known method to test this is to press a key corresponding to the letter that appears on the screen. In such experiments, the stimuli types are given randomly in different sequences. Normally, this kind of experiment is not favored in reaction time experiments because it is always the space bar that the users are instructed to press in response to the stimuli being presented to them.

The mean simple reaction times for college age individuals were taken to be 190 m (0.19 sec) for light stimuli and about 160 ms for sound stimuli.[3-6] Eckner et al., in 2010, measured the average reaction times of NCAA football players were 203 ms when determined with an ordinary falling meter stick; and when the same was measured with the computer, it was 0.268.[7] For a simple visual stimulus, it is mostly the reaction times measured at Clemson, which read closer to 0.268.

Donders, the pioneer of the reaction time, studied all the three kinds of reaction times and demonstrated that a simple reaction is shorter than a recognition reaction time and the longest of the three was the choice reaction time.[8] O'Shea and Bashore did a thorough review of such early studies.[9] Many studies by Laming,[10] Brebner and Welford,[6] and Teichner and Krebs[11] concluded that a complex stimulus, for example, several letters in symbol recognition against one letter, elicits in the user a slower reaction time. Another interesting experiment was carried out by Miller and Low to prove that the processing time decides the differences in reaction time.[12] The relation between VRT and the type of stimuli was observed by Shenvi and Balasubramanian.[13]

Reaction time is also affected by exercise and playing games. The effect of simple eye exercise and pranayama in the improvement of VRT was studied by Gosewade et al.[14] Ghuntla et al. showed that basketball players have significant less VRT than the healthy controls.[15]

MATERIALS AND METHODS

The study was carried out among 112 first year medical students in the age group 18-20. The institutional ethical clearance was obtained before initiating the study. The study population was selected in such a way that the subject were easily accessible, and the study can be done within the stipulated period of 2-month. There were 66 males and 46 females who completed the study. Out of them, 60 were emmetropic subjects and 52 were myopic subjects. Subjects who are smokers and/or alcoholics, who had clinical evidence of any illness, suffering from any psychiatric disorder affecting their psychomotor abilities, were excluded from the study. Informed consent was obtained from all the subjects after they receive verbal explanation of the nature of the study. The study was carried out with the help of discriminatory and choice reaction time apparatus (Anand Agencies, Pune) in the same time of the day for all subjects to avoid influence of circadian rhythm.

With the help of this apparatus, binocular simple reaction time of the subjects was recorded. The participants were taken to the research lab which has optimal lighting condition. Subjects were requested to sit on one side of the apparatus and the examiner the other side. There was almost 80-100 cm distance between the visual stimuli and the subject's eye. The subject was instructed to press the response button immediately when he/she detect the stimulus. The response button terminated the clock counter. This time was taken as VRT in milliseconds. This process was repeated for 5 times, and average value of reaction time was taken as the final reaction time for that sensory modality of that subject. For myopic subjects, VRT was taken before and after correction of their refractive error. Subjects were presented with two visual stimuli, red and green.

The simple VRT of emmetropic subject for red light was noted as emmetropic red reaction time and that of green light was noted as emmetropic green reaction time. And for myopic subjects, as VRT was collected both before and after correction of the refractive error their data were noted in the following way: Myopic corrected red reaction time, myopic uncorrected red reaction time, myopic corrected green reaction time, and myopic uncorrected green reaction time.

The reaction times were statistically analyzed using Microsoft Excel, Analyse-it, and SPSS software. After checking for the normality of the data by Shapiro-Wilk test, the data were found to be uniformly distributed. So, parametric tests were used to compare the results.

The level of significance between myopic individuals before and after correcting refractive error was analyzed by students' paired *t*-test. $P < 0.05$ was considered significant.

The level of significance between myopic and emmetropic individuals was tested by students' unpaired test. The observation was taken as significant if $P < 0.05$.

RESULT

VRT is found to be significantly ($P < 0.05$) more in uncorrected myopic subjects as compared to emmetropic subjects for both red and green light stimuli (Table 1).

Surprisingly, VRT is found to be significantly less ($P < 0.05$) in emmetropic subjects as compared to myopic subjects even after correcting the refracting error (Table 2).

However, there is no significant difference in VRT when it is compared among the myopics before and after correcting the refractive error. ($P > 0.05$) (Table 3).

DISCUSSION

As simple VRT of myopic subjects is found to be longer than emmetropic subjects, there comes a necessary to find out the reason behind it. Reaction time is affected by various factors such as age, sex, left or right handedness, central versus peripheral vision, fatigue, fasting, breathing cycles, personality type, exercise, and intelligence. Reaction time has two components a sensory and a motor component.

Myopia is a refractive error due to excessive elongation of eyeball or the eye lens is too curved. Because of these factors, the light rays passing through the eye lens converge in front of retina. This creates a blurred image to be perceived by myopic people. However, this error can be corrected using a concave lens of suitable power.

The present study shows that myopic individuals have prolonged reaction time than age- and sex-matched individuals. The myopic people always perceive a blurred image. The increase in blur reduces the perceived brightness. Thus, the blur and the reduced brightness would account for lengthening the sensory component of the RT.

Surprisingly, the myopic subjects with refractive error being corrected using lens also have increased reaction time than emmetropic subjects. This might be due to the fact that the light rays coming from the stimuli suffer refraction through obstacles such as spectacles. When myopic people use spectacles, the visual filed is limited by the frames of the spectacles which may account for increased RT. Therefore, there is a significant difference in VRT between the emmetropic subjects perceiving light rays directly and myopic subjects perceiving light rays passing through

Table 1: Visual reaction time to red and green light stimuli in uncorrected myopic and emmetropic subjects

Stimuli	Emmetropic (ms)		Myopic uncorrected (ms)		*P*
	Average	SD	Average	SD	
Red	192.14	26.21	214.22	28.41	0.00,002 (<0.05)
Green	186.49	25.31	211.77	26.60	0.0,000,007 (<0.05)

Table 2: Visual reaction time to red and green light stimuli in corrected myopic and emmetropic subjects

Stimuli	Emmetropic (ms)		Myopic corrected (ms)		*P*
	Average	SD	Average	SD	
Red	192.14	26.21	206.43	28.78	0.004 (<0.05)
Green	186.49	25.31	204.26	26.82	0.0003 (<0.05)

Table 3: Visual reaction time to red and green light stimuli in corrected and uncorrected myopic subjects

Stimuli	Myopic corrected (ms)		Myopic uncorrected (ms)		*P*
	Average	SD	Average	SD	
Red	206.43	28.78	214.22	28.41	0.08 (>0.05)
Green	204.26	26.82	211.77	26.60	0.08 (>0.05)

different media. Thus, myopic subjects have an increased VRT.

From the study, it is implied that myopia does affect VRT. A very long reaction time indicates impairment of psychomotor skills. Professions like driving heavy machinery, drivers, people who are responsible for taking critical decisions such as intensive care doctors, intensivists, ground clearance in aeronautical engineering, and traffic controllers do need quick reaction time which can be affected by refractive errors.

Driving is often described as visuo-motor task. The "shortest stopping distance" as recommended by the highway code for various speeds of vehicle divides the distance into "thinking and braking distances." VRT is an important component of thinking distance, the pedal response, and mechanical action of the brakes. The perception time of 675 ms is assumed for the optimal conditions. So, VRT can be used as a screening test for employment to ensure safety and as a preventive measure.

CONCLUSION

The present study concludes that myopic people have greater reaction time than emmetropic people even though when their refractive error is corrected. This adds refractive error as a new member in the row of factors that affects the VRT. This study frames a question in our mind whether the myopic people who have undergone laser surgery for correcting refractive error would have normal reaction time or not and thereby extending the study to more subgroups. This study has further scope of expanding the subjects using hypermetropics, myopics with distant VRT comparison using choice reaction time, etc.

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